(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 353 021 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89307537.4

(51) Int. Cl.5: A 23 L 3/34

(22) Date of filing: 25.07.89

(30) Priority: 29.07.88 NZ 225620

(43) Date of publication of application:
31.01.90 Bulletin 90/05

(84) Designated Contracting States:
AT BE CH DE ES FR GB GR IT LI LU NL SE

flushing

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(54) Controlled environment transportation of respiring comestibles.

(57) A method of transporting a quantity of a comestible which may be subject to degradation as a result of respiration during transportation, comprising the steps of:

(a) sealing or substantially sealing said quantity of the respiring comestible within a container as hereinbefore described sufficiently to ensure that less oxygen of the ambient air can diffuse into the container than is required for full respiration by the respiring comestible, flushing the container with an oxygen low or oxygen free gas so as to provide a reduced oxygen level in the sealed or substantially sealed container, such flushing occurring before, during and/or after said sealing or substantial sealing, and

(b) transporting the container with the respiring comestible therein while (i) monitoring the oxygen level within said container and automatically adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values and (ii) monitoring the carbon dioxide level within said container and adjusting the carbon dioxide level as necessary in response to such monitoring towards an optimum or predetermined value or range of values without reliance upon flushing with an oxygen low or oxygen free gas, said adjustment being firstly by means of a scrubbing of the air within said container but if necessary may additionally or instead include a positive infusion of ambient air into the container.

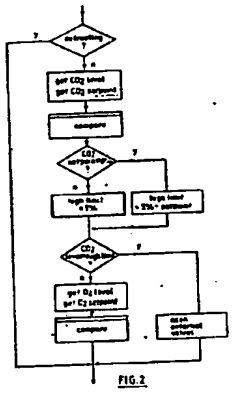

FIG.2

EP 0 353 021 A1

Bundesdruckerei Berlin

Description

CONTROLLED ENVIRONMENT TRANSPORTATION OF RESPIRING COMESTIBLES

It is therefore an object of the present invention to provide a method and related apparatus which will provide some safeguard in the event the carbon dioxide content of the container rises above a desirable level.

Accordingly the present invention, in one aspect, consists in a method of transporting a quantity off comestible which may be subject to degradation as a result of respiration during transportation, comprising the steps of:

(a) sealing or substantially sealing said quantity of the respiring comestible within a container as hereinbefore described sufficiently to ensure that less oxygen of the ambient air can diffuse into the container than is required for full respiration by the respiring comestible, flushing the container with an oxygen low or oxygen free gas so as to provide a reduced oxygen level in the sealed or substantially sealed container, such flushing occurring before, during and/or after said sealing or substantial sealing, and

(b) transporting the container with the respiring comestible therein while (i) monitoring the oxygen level within said container and automatically adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values and (ii) monitoring the carbon dioxide level within said container and adjusting the carbon dioxide level as necessary in response to such monitoring towards an optimum or predetermined value or range appropriate in other carriage spaces, eg. the cargo hold of an aircraft, ship, train or the like and therefore for the purposes of the present specification the word "container" as used herein relates not only to shipping containers but to any means defining a storage space for such comestibles.

In a system such as disclosed in the aforementioned patent specifications the quantity of carbon dioxide capable of being absorbed is finite where reliance is placed upon a finite amount of a carbon dioxide absorbing medium such as, for example, a scrubbing unit including hydrated lime. Moreover there is also the prospect of carbon dioxide build up where for some reason or another a flow of the gaseous environment of the container can not be ducted through any such carbon dioxide scrubbing device.

of values without reliance upon flushing with an oxygen low or oxygen free gas, said adjustment being firstly by means of a scrubbing of the air within said container but if necessary may additionally or instead include a positive infusion of ambient air into the container.

Preferably said container is refrigerated and there is automatic adjustment of the temperature.

In a further aspect the present invention consists in apparatus for transporting a quantity of respiring comestibles which may be degraded by respiration, said apparatus comprising:

transportable means defining a volume of a gaseous environment for said comestibles capable of being substantially sealed and in which the comestibles to be transported can be carried,

means to seal or substantially seal said volume after loading with said comestibles such that less oxygen from the ambient air can diffuse into the environment than is required for the respiration,

means to enable flushing of the environment with an oxygen microprocessor 1, which operates according to a program stored in read-only memory 2. The microprocessor reads and writes to and from read/write memory 3 and a removable cassette in cassette unit 4. A gas pump 5 continuously draws air from the container through inlet 15 and consecutively through O_2 detector 6 and CO_2 detector 7. Outlet 16 may return the sampled air to the container or its surroundings. A temperature detector 8 monitors approximately the temperature of the controller itself. Analog multiplexer 9 passes any of the three detector output signals to analog-to-digital converter 10 in response to commands by the microprocessor. The selected detector signal is then passed to the microprocessor on a common data/address bus 11.

Microprocessor 1 calculates actual CO_2 and O_2 levels by applying corrections to the detected levels as necessary depending on the detectors used. The CO_2 and O_2 levels according to the most recent sample are then shown on display 12, and may at suitable intervals be stored on the cassette, in addition to the detected temperature and the time according to real time clock 13. The microprocessor compares the actual CO_2 and O_2 levels with predetermined setpoints, these being preferred levels which vary with particular comestibles. Action of the container valves is controlled by the the O_2 level and setpoint are being compared, a positive error indicates that the level is above the setpoint and the external valve should be closed, while a negative error indicates that the level is undesirably low and the external valves should be controller described in relation to Figures 8-10 of those specifications. Such figures and the description thereof is hereby herein incorporated by way of reference. The controller is a microprocessor based unit which measures, controls, displays and logs the levels of carbon dioxide and oxygen in a container as hereinbefore defined, particularly a refrigerated marine shipping container. Control of the gas levels may be achieved via solenoid valves built into the container and connected to the controller. In the case of CO_2, valves are provided to (i) allow passage of container air through a scrubber unit in order to prevent the CO_2 level of the container air rising above a predetermined level, and (ii) allow an infusion of ambient air to the container should the CO_2 level rise above a higher predetermined level, such as in the event of failure of the scrubber action.

In the case of O_2, the external valves of (ii) allow an infusion of ambient air to the container in order to prevent the O_2 level of the container air from falling below a predetermined level. The controller is intended to be portable and of a size and shape to fit in the electrical power control box of such containers.

Referring to Figure 1, the controller schematically comprises a opened or remain open.

Principal features of a specific embodiment of the invention will now be described. In this embodiment the microprocessor 1 is an Intel 8085 8-bit processor. The other components of the controller shown in Figure 1 interface with the data/address bus via an 8255 programmable peripheral interface, except that the external ports 15 include an 8251 programmable communications interface for connection of the controller to a further microprocessor if desired. The ROM 2 in which the microprocessor program is stored comprises two 32K 2732 EPROMS while the RAM 3 comprises a 2K 6116 static RAM. The analog multiplexer 9 and analog-to-digital converter 10 comprise 4051 and ADC0802 chips respectively. The setpoints for a particular container load are stored in the cassette after input from a portable computer via the 8251 interface as noted above, and the controller cannot exercise the routine of Figure 2 unless the cassette is in place. Deadband values (O_2: ±0.3%, CO_2: ±0.5%) are stored in the EPROMS and are not varied between loads.

A "Teledyne"* type A5 microfuel cell detects oxygen in the container air up to 25% by volume and with 10% accuracy of reading. The cell output is temperature dependent for which compensation is achieved via a thermistor in the cell output circuit.

* Teledyne Analytical Instruments
Box 1580
City of Industry
CA 91749 USA

A four filament "Gowmac"* thermal conductivity cell is used to detect the presence of carbon dioxide in the container air up to 25% by volume. Each filament of the detector comprises one arm of a That part of the microprocessor program which enacts the present invention will now be described with reference to the flow charts of Figures 2 and 3.

* Gowmac USA
Box 32
NH 08805 USA

In Figure 2, action may be taken in respect of the container CO_2 and O_2 levels, provided that the container is not undergoing defrosting. The microprocessor then proceeds to compare the CO_2 level with the CO_2 setpoint and then with the CO_2 high limit value. If the CO_2 high limit is exceeded, ambient air is drawn into the container to lower the container air CO_2 level, otherwise the O_2 level is compared with the O_2 setpoint. CO_2 high limit control thus overrides O_2 level control. In making each comparison and operating valves if necessary, program execution passes to the routine shown in Figure 3.

Referring to Figure 3, the microprocessor calculates an error equal to the deviation of the CO_2 or O_2 level from the corresponding setpoint, and calculates a control value equal to the error magnitude less the deadband amplitude. If the control value is negative the error is within the deadband and the existing valve status is maintained. If the control value is positive, the error is outside the deadband and action may be taken as follows. If the CO_2 level and setpoint are being compared, a positive error indicates that the level is undesirably high and the scrubber valve should be opened or remain open, while a negative error indicates that the level is below the setpoint and the scrubber valve should be closed or remain closed. If resistance bridge, two filaments being used for gas measurement and two filaments for reference. Such a detector is not intrinsically CO_2 sensitive but also reflects the O_2 and NO_2 levels of the container air. The microprocessor therefore compensates the conductivity cell output according to the detected O_2 level and an estimate of the N_2 level. The CO_2 detector is also temperature dependent for which further compensation is made by the microprocessor via the output of temperature detector 8. Overall, the CO_2 level obtained with 1% accuracy.

A "Wisa"* vibrator type pump draws container air through the detectors at 0.2-0.5 1/minute. The air is filtered before passage through the CO_2 detector.

* Wisa Precision Pumps
Bayonne
NJ 07002 USA

Each detector output is read by the microprocessor approximately once every second and a running average for each level is calculated to overcome noise, the detector outputs being compensated as noted previously. The latest averages are displayed on the front panel of the controller and compared with the setpoints. The container CO_2 and O_2 levels and controller temperature are recorded on the cassette approximately every 8 hours when the container and controller are in use. There is provision to monitor and record the temperature within the container through a further communications port in the container, not shown in Figure 1, if desired.

Appendix I is a portion of an 8085 assembly language program listing in which lines 222-335 correspond approximately to the flow chart of Figure 2.

Appendix II is a portion of an 8085 assembly language program listing in which lines 1134-1168 carry out CO_2 level compensation for the CO_2 detector temperature, lines 1177-1200 carry out CO_2 level compensation in accord with the O_2 level, and lines 1219-1272 correspond approximately to the flow chart of Figure 3.

It is believed that apparatus and methods in accordance with the present invention define widespread application in the transportation industry.

Claims

1. A method of transporting a quantity of a comestible which may be subject to degradation as a result of respiration during transportation, comprising the steps of:

(a) sealing or substantially sealing said

quantity of the respiring comestible within a container as hereinbefore described sufficiently to ensure that less oxygen of the ambient air can diffuse into the container than is required for full respiration by the respiring comestible, flushing the container with an oxygen low or oxygen free gas so as to provide a reduced oxygen level in the sealed or substantially sealed container, such flushing occurring before, during and/or after said sealing or substantial sealing, and

(b) transporting the container with the respiring comestible therein while (i) monitoring the oxygen level within said container and automatically adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values and (ii) monitoring the carbon dioxide level within said container and adjusting the carbon dioxide level as necessary in response to such monitoring towards an optimum or predetermined value or range of values without reliance upon flushing with an oxygen low or oxygen free gas, said adjustment being firstly by means of a scrubbing of the air within said container but if necessary may additionally or instead include a positive infusion of ambient air into the container.

2. A method as claimed in claim 1 wherein said container is refrigerated and there is automatic adjustment of the temperature.

3. Apparatus for transporting a quantity of respiring comestibles which may be degraded by respiration, said apparatus comprising:
transportable means defining a volume of a gaseous environment for said comestibles capable of being substantially sealed and in which the comestibles to be transported can be carried,
means to seal or substantially seal said volume after loading with said comestibles such that less oxygen from the ambient air can diffuse into the environment than is required for the respiration,
means to enable flushing of the environment with an oxygen free or low gas to reduce the oxygen content thereof below that of ambient air,
means to monitor the oxygen content of the environment, means to monitor the carbon dioxide content of the environment,
means responsive to the means to monitor said oxygen content to cause a positive infusion of ambient air into the environment should the oxygen content be or fall below a predetermined value,
means responsive to the means to monitor said carbon dioxide content to cause passage of gas within the environment through means to scrub at least some of the carbon dioxide therefrom should said carbon dioxide content rise above a first predetermined value, and
means responsive to the means to monitor said carbon dioxide content to cause a positive infusion of ambient air into the environment should said carbon dioxide content not be maintained below a higher second predetermined value by said means to scrub at least some carbon dioxide from the environment.

4. Apparatus as claimed in claim 2 or 3 wherein said environment is within a container of the kind hereinbefore described.

5. Apparatus as claimed in claim 2 wherein there is provided means to monitor the temperature of the environment and additionally means responsive to the means to monitor the temperature of the environment to adjust at least downwardly the temperature of the environment towards a predetermined value.

6. A gas controller for a container of the kind hereinbefore described having means for extraction of CO_2 from the container air and means for exchange of ambient air with container air, said controller comprising:
a microprocessor, read-only memory and read-write memory connected to a common communication bus;
a carbon dioxide detector for monitoring the level of carbon dioxide in the container air;
an oxygen detector for monitoring the level of oxygen in the container air;
means for connecting the output of said detectors to said bus;
and an output port connected to said bus for output from said microprocessor of control signals which activate/deactivate said means for extraction and means for exchange;
wherein said microprocessor executes a program stored in said read-only memory which program:

(a) monitors said carbon dioxide and oxygen level;

(b) activates/deactivates said means for extraction if said carbon dioxide level rises above/falls below a predetermined carbon dioxide level or range of levels;

(c) activates/deactivates said means for exchange if said carbon dioxide level rises above/falls below a predetermined carbon dioxide high limit or range of limits; and

(d) activates/deactivates said means for exchange if said oxygen level falls below/rises above a predetermined oxygen level or range of levels.

7. A gas controller according to claim 6 wherein said activation/deactivation comprises opening/closing of solenoid valves

8. A gas controller according to claim 6 or claim 7 wherein said predetermined levels are preferred levels for transport of respiring comestibles within said container.

9. A gas controller according to any one of claims 6 to 8 wherein said predetermined carbon dioxide limit is a limit above which unacceptable damage occurs to comestibles being transported in said container.

10. A gas controller according to any of one of claims 6 to 9 wherein said means for connecting the output of said detectors to said bus comprises an analog multiplexer in series with an analog-to-digital converter.

11. A gas controller according to any one of claims 6 to 10 wherein said program records at predetermined intervals said carbon dioxide and oxygen levels in a removable memory element connected to said microprocessor via said bus.

APPENDIX 1

```
ISIS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
KANSFRESH 300 SERIES CONTROLLER

 LOC  OBJ          LINE        SOURCE STATEMENT

 00C0 CD0506   C    214          CALL     LOG
 00C3 AF            215          XRA      A
 00C4 32A400   D    216          STA      LOGF     ;AND RESET LOG FLAG
                    217
                    218 ; COMPENSATE AND SCALE INPUTS
 00C7 CDA006   C    219 MAIN1:   CALL     TFCMP
                    220
                    221 ; CONTROL OUTPUTS
 00CA 3A0430        222          LDA      PORTA
 00CD 47            223          MOV      B,A
 00CE E620          224          ANI      DFRST    ;DEFROSTING?
 00D0 CAA801   C    225          JZ       DPPTR    ;YES, EXIT
                    226
 00D3 78            227          MOV      A,B
 00D4 E680          228          ANI      CART     ;CARTRIDGE INSERTED
 00D6 C2A801   C    229          JNZ      DPPTR    ;NO, EXIT
                    230
                    231 ; DO CONTROL ACTION ON CO2
 00D9 110A40        232          LXI      D,ESPCO2 ;GET CO2 SET POINT
 00DC CD1E08   C    233          CALL     SPCV     ;CONVERT
                    234
 00DF 012300   D    235          LXI      B,TCO2   ;CO2 VALUE
 00E2 113300   D    236          LXI      D,TMP    ;SET POINT
 00E5 214300   C    237          LXI      H,DBCO2  ;DEADBAND
 00E8 3E00          238          MVI      A,0      ;NEGATIVE CONTROL ACTION
 00EA CDDB07   C    239          CALL     CTLA
                    240
 00ED DA0201   C    241          JC       CON3
 00F0 79            242          MOV      A,C
 00F1 B7            243          ORA      A
 00F2 3A0530        244          LDA      PORTB
 00F5 CAFD00   C    245          JZ       CON1
 00F8 E6FB          246          ANI      NOT RYCO2
 00FA C3FF00   C    247          JMP      CON2
 00FD F604          248 CON1:    ORI      RYCO2
 00FF 320530        249 CON2:    STA      PORTB
                    250
 0102 213300   D    251 CON3:    LXI      H,TMP    ;CLEAR TEMP
 0105 0604          252          MVI      B,4
 0107 CD0000   E    253          CALL     CLRM
                    254
                    255 ;CHECK CO2 LIMIT
 010A 110A40        256          LXI      D,ESPCO2 ;GET CO2 SET POINT
 010D CD1E08   C    257          CALL     SPCV     ;CONVERT
                    258
                    259 ;        SET POINT < 3%
 0110 013300   D    260          LXI      B,TMP    ;SET POINT
 0113 114F00   C    261          LXI      D,PC3    ;- 3%
 0116 213700   D    262          LXI      H,TMP+4
 0119 CD0000   E    263          CALL     SUB32
 011C 3A3A00   D    264          LDA      TMP+7    ;GET SIGN BIT
 011F 0F            265          RRC               ;-VE
 0120 DA3501   C    266          JC       CON4     ;YES, SET TO 3%
                    267
                    268 ;        > 3%  SET POINT = SET POINT + 3%
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;IS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
;ANSFRESH 300 SERIES CONTROLLER

LOC  OBJ          LINE        SOURCE STATEMENT

0123 013300    D   269         LXI     B,TMP   ;SET POINT =
0126 115300    C   270         LXI     D,PC5   ;SET POINT +
0129 213400    D   271         LXI     H,TMP+3 ;5%
012C CD0000    E   272         CALL    AD032
012F 113800    D   273         LXI     D,TMP+5 ;-> SETPOINT + 5%
0132 C33801    C   274         JMP     CON5
                   275
                   276 ;       < 5%  SET POINT = 5%
0135 115300    C   277 CON4:   LXI     D,PC5   ;-> 5%
                   278
0138 012300    D   279 CON5:   LXI     B,TC02  ;-> C02 COMPENSATED
013B 214500    C   280         LXI     H,PC1   ;-> DEADBAND
013E 3E00          281         MVI     A,0     ;CONTROL +VE
0140 CDDB07    C   282         CALL    CTLA
                   283
                   284 ;       DO CONTROL ACTION
0143 DA5801    C   285         JC      CON6    ;ACTION REQUIRED, NO ->
0146 79            286         MOV     A,C     ;ON OR OFF
0147 B7            287         ORA     A
0148 3A0530        288         LDA     PORTB   ;GET PORT
014B CA5301    C   289         JZ      CON4    ;OFF ->
014E E6FD          290         ANI     NOT RYTB ;LIMIT OFF
0150 C35501    C   291         JMP     CON8
0153 F602          292 CON4:   ORI     RYTB    ;LIMIT ON
0155 320530        293 CON8:   STA     PORTB
                   294 ;
0158 3A0530        295 CON6:   LDA     PORTB   ;CHECK LIMIT
015B E602          296         ANI     RYTB    ;LIMIT SET?
015D CA6B01    C   297         JZ      CONC    ;NO, CONT
0160 3A0530        298         LDA     PORTB   ;GET PORT AGAIN
0163 F601          299         ORI     RY02    ;YES, SET RY02
0165 320530        300         STA     PORTB
0168 C3A901    C   301         JMP     DPPTR   ;NEXT FUNCTION
                   302
016B 213300    D   303 CONC:   LXI     H,TMP   ;CLEAR TEMP
016E 0608          304         MVI     B,8
0170 CD0000    E   305         CALL    CLRM
                   306
                   307 ;DO CONTROL ACTION ON OXYGEN
0173 110E40        308         LXI     D,ESP02 ;OXYGEN SET POINT
0176 CD1E09    C   309         CALL    SPCV    ;CONVERT
                   310
                   311 ;POINT TO APPROPIATE O2 CELL FOR CONTROL
0179 210500    D   312         LXI     H,AD2A  ;-> O2A
017C 3A6700    D   313         LDA     02CF    ;FLAG SET?
017F B7            314         ORA     A
0180 CA8601    C   315         JZ      CON7    ;NO, CONT
                   316
0183 210F00    D   317         LXI     H,AD2B  ;YES POINT TO REF
                   318
0186 44            319 CON7:   MOV     B,H     ;H,L -> O2 VALUE TO USE
0187 4D            320         MOV     C,L     ;TRANSFER TO B,C
0188 113300    D   321         LXI     D,TMP   ;-> O2 SET-POINT
018B 214700    C   322         LXI     H,DB02  ;-> O2 DEAD BAND
018E 3EFF          323         MVI     A,0FFH
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SIE-II 8080/8085 MACRO ASSEMBLER, V4.1          TPCVP
FANSFRESH 300 SERIES CONTROLLER

 LOC  OBJ          LINE        SOURCE STATEMENT

0190 CDD507   C    324          CALL    CTLA
                   325
0193 DAA801   C    326          JC      DPPTR
0196 79            327          MOV     A,C
0197 B7            328          ORA     A
0198 3A0530        329          LDA     PORTB
019B CAA301   C    330          JZ      CON8
019E E6FE          331          ANI     NOT RYO2
01A0 C3A501   C    332          JMP     CON9
01A3 F601          333 CON8:    ORI     RYO2
01A5 320530        334 CON9:    STA     PORTB
                   335
                   336 ; SET DISPLAY POINTERS TO CO2 AND O2
01A8 112300   D    337 DPPTR:   LXI     D,TCO2  ;-> CO2 AVERAGE
01AB 210800   D    338          LXI     H,AO2A  ;-> O2A AVERAGE
01AE 3A6900   D    339          LDA     O2CF    ;O2 CONTROL FLAG
01B1 B7            340          ORA     A       ;SET?
01B2 CAB801   C    341          JZ      KPR     ;YES, LEAVE OA2
01B5 210F00   D    342          LXI     H,AO2B  ;NO, CHANGE TO O2B
                   343
                   344 ; ANY KEYS PRESSED
01B8 3A6500   D    345 KPR:     LDA     KEYF
01BB B7            346          ORA     A
01BC CA1F02   C    347          JZ      MAIN3   ;NO, CONT
                   348
                   349 ; NOW SEE WHICH KEY
01BF 3A0630        350          LDA     PORTC   ;GET KEY
01C2 E60F          351          ANI     0FH     ;STRIP UPPER
01C4 210800   D    352          LXI     H,AO2A  ;-> O2A
01C7 110F00   D    353          LXI     D,AO2B  ;-> O2B
01CA FE0D          354          CPI     SWP1    ;O2A & O2B REQUIRED?
01CC CA0902   C    355          JZ      KPR1    ;YES, JUMP OUT
01CF 211300   D    356          LXI     H,AT1   ;NO, -> TEMP 1
01D2 111700   D    357          LXI     D,AT2   ;-> TEMP 2
01D5 FE07          358          CPI     SWP3
01D7 CA0902   C    359          JZ      KPR1
01DA 211700   D    360          LXI     H,TT4   ;TEMPS 3 & 4
01DD 111B00   D    361          LXI     D,AT3
01E0 FE09          362          CPI     SWP4
01E2 CA0902   C    363          JZ      KPR1
01E5 B7            364          ORA     A       ;KEY RELEASED?
01E6 CA0902   C    365          JZ      KPR1    ;YES, EXIT
01E9 213300   D    366          LXI     H,TMP   ;CLEAR TEMP
01EC 0608          367          MVI     B,8
01EE CD0000   E    368          CALL    CLRM
01F1 110E40        369          LXI     D,ESPC2 ;O2 SET POINT
01F4 CD1E08   C    370          CALL    SPCV    ;CONVERT
01F7 3A3400   D    371          LDA     TMP+1   ;GET VALUE
01FA 323800   D    372          STA     TMP+5
01FD 110A40        373          LXI     D,ESPCO2 ;O2 SET POINT
0200 CD1E08   C    374          CALL    SPCV
0203 213700   D    375          LXI     H,TMP+4
0206 113300   D    376          LXI     D,TMP
                   377
                   378 ; KEY PRESSED
```

APPENDIX 2

```
IS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
ANSFRESH 300 SERIES CONTROLLER

LOC  OBJ          LINE        SOURCE STATEMENT

06FF 35           1120          DCR     M
0700 C2B106   C   1121          JNZ     AVRG
                  1122
0703 3EFF         1123          MVI     A,0FFH  ;SET FIRST TIME FLAG
0705 32A600   D   1124          STA     FIRSTF
                  1125
                  1126 ;NOW COMPENSATE THE AVERAGE VALUES .
                  1127 ;EXPAND TEMPERATURE SCALE
0708 011F00   D   1128 TFC2:    LXI     B,AT4   ;AVERAGE TEMP
070B 11B307   C   1129          LXI     D,THR   ; X 3 =
070E 212700   D   1130          LXI     H,TT4   ;TRUE TEMPERATURE
0711 CD0000   E   1131          CALL    MUL32
                  1132
                  1133 ;COMPENSATE CO2 FOR TEMPERATURE
0714 012700   D   1134          LXI     B,TT4   ;DELTA T
0717 11CB07   C   1135          LXI     D,K4
071A 213D00   D   1136          LXI     H,TMP1
071D CD0000   E   1137          CALL    SUB32
                  1138
0720 013D00   D   1139          LXI     B,TMP1  ;DELTA T X 200
0723 11CF07   C   1140          LXI     D,K5
0726 213300   D   1141          LXI     H,TMP
0729 CD0000   E   1142          CALL    MUL32
                  1143
072C 010700   D   1144          LXI     B,ACO2  ;CO2A X 1000
072F 11D307   C   1145          LXI     D,K6
0732 212300   D   1146          LXI     H,TCO2
0735 CD0000   E   1147          CALL    MUL32
                  1148
0738 012300   D   1149          LXI     B,TCO2  ;(CO2A X 1000)
073B 113300   D   1150          LXI     D,TMP   ;- ((TT4 - 64000) X 200)
073E 212300   D   1151          LXI     H,TCO2
0741 CD0000   E   1152          CALL    SUB32
                  1153
0744 013D00   D   1154          LXI     B,TMP1  ;(TT4 - 64000)/569
0747 11D707   C   1155          LXI     D,K7
074A 213D00   D   1156          LXI     H,TMP1
074D CD0000   E   1157          CALL    DIV32
                  1158
0750 01D307   C   1159          LXI     B,K6    ;1000 - (DELTA T - 64000)
0753 113D00   D   1160          LXI     D,TMP1  ;                ----------------
0756 213D00   D   1161          LXI     H,TMP1  ;                     569
0759 CD0000   E   1162          CALL    SUB32
                  1163
075C 012300   D   1164          LXI     B,TCO2  ;A - 0.2(DELTA T)
075F 113D00   D   1165          LXI     D,TMP1  ;-----------------
0762 212300   D   1166          LXI     H,TCO2  ; 1 - 0.0043(DELTA T)
0765 CD0000   E   1167          CALL    DIV32
                  1168
                  1169 ;COMPENSATE CO2 FOR O2 CONCENTRATION
0768 010B00   D   1170          LXI     B,AO2A  ;-> O2A
076B 3A6900   D   1171          LDA     O2CF    ;GET APPROPIATE
076E B7           1172          ORA     A       ;O2 READING
076F CA7507   C   1173          JZ      AVG1
0772 010F00   D   1174          LXI     B,AO2B
```

```
ISIS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFOVF
TRANSFRESH 300 SERIES CONTROLLER

 LOC  OBJ          LINE        SOURCE STATEMENT

                   1175
                   1176 ;COMPENSATE CO2 DATA
 0775 115B07   C   1177 AVG1:   LXI     D,TEN    ;C2 / 10
 0778 213D00   D   1178         LXI     H,TMP1
 077B CD0000   E   1179         CALL    DIV32
                   1180
 077E 012300   D   1181         LXI     B,TCO2   ;CO2 + 02/10
 0781 113D00   D   1182         LXI     D,TMP1
 0784 213D00   D   1183         LXI     H,TMP1
 0787 CD0000   E   1184         CALL    ADD32
                   1185
 078A 013D00   D   1186         LXI     B,TMP1   ;(CO2 + 02/10) - 2(UNITS)
 078D 11AF07   C   1187         LXI     D,TWOU
 0790 213D00   D   1188         LXI     H,TMP1
 0793 CD0000   E   1189         CALL    SUB32
                   1190
 0796 013D00   D   1191         LXI     B,TMP1   ;(CO2 - 2 + 02/10)
 0799 11B707   C   1192         LXI     D,NINE   ;-----------------
 079C 213D00   D   1193         LXI     H,TMP1   ;       9
 079F CD0000   E   1194         CALL    DIV32
                   1195
 07A2 013D00   D   1196         LXI     B,TMP1   ;(CO2 - 2 + 02/10) X 10/9
 07A5 11BB07   C   1197         LXI     D,TEN
 07A8 212300   D   1198         LXI     H,TCO2
 07AB CD0000   E   1199         CALL    MUL32
                   1200
 07AE C9           1201         RET
                   1202
 07AF 7D14         1203 TWOU:   DW      5244,0   ;TWO (UNITS)
 07B1 0000
 07B3 0300         1204 THR:    DW      3,0      ;THREE
 07B5 0000
 07B7 0900         1205 NINE:   DW      9,0      ;NINE
 07B9 0000
 07BB 0A00         1206 TEN:    DW      10,0     ;TEN
 07BD 0000
 07BF ED17         1207 K1:     DW      6125,0   ;CONSTANT 1
 07C1 0000
 07C3 39E8         1208 K2:     DW      22585,0  ;CONSTANT 2
 07C5 0000
 07C7 1000         1209 K3:     DW      16,0     ;CONSTANT 3
 07C9 0000
 07CB 60FA         1210 K4:     DW      64000,0  ;CONSTANT 4
 07CD 0000
 07CF 1400         1211 K5:     DW      20,0     ;CONSTANT 5
 07D1 0000
 07D3 E803         1212 K6:     DW      1000,0   ;CONSTANT 6
 07D5 0000
 07D7 3902         1213 K7:     DW      569,0    ;CONSTANT 7
 07D9 0000
                   1214
                   1215 ;*************************************************
                   1216
                   1217 ;CLTA:-          CONTROL ACTION SUBROUTINE
                   1218
```

```
ISIS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
SANGFRESH 300 SERIES CONTROLLER

LOC  OBJ          LINE        SOURCE STATEMENT

                  1219 ;ENTER: BC -> INPUT VARIABLE
                  1220 ;       DE -> SET-POINT VALUE
                  1221 ;       HL -> DEADBAND VALUE
                  1222 ;       A = CONTROL ACTION, 00=+VE, FF=-VE
                  1223
                  1224 ;EXIT:  CARRY, NO ACTION ERROR<DEDBAND
                  1225 ;       C = ACTION 00(OFF), FF(ON).
                  1226
                  1227 ;-----------------------------------------------------
                  1228
07D8 F5           1229 CTLA:   PUSH    PSW      ;SAVE ACTION
07DC E5           1230         PUSH    H        ;SAVE DEADBAND POINTER
                  1231
                  1232         ;ENTERS WITH BC, DE SET
07DD 213300    D  1233         LXI     H,TMP    ;ERROR
07E0 CD0000    E  1234         CALL    SUB32
                  1235
07E3 AF           1236         XRA     A        ;RESET
07E4 326800    D  1237         STA     NEGF     ;NEGATIVE FLAG
                  1238
07E7 213A00    D  1239         LXI     H,TMP+3
07EA 7E           1240         MOV     A,M      ;ERROR -VE?
07EB 07           1241         RLC
07EC D2FA07    C  1242         JNC     $+14     ;NO, ->
07EF 3EFF         1243         MVI     A,0FFH   ;YES,
07F1 326800    D  1244         STA     NEGF     ;NEGATIVE FLAG
07F4 213300    D  1245         LXI     H,TMP
07F7 CD0000    E  1246         CALL    COMPHL   ;MAKE POSITIVE
                  1247
07FA 013300    D  1248         LXI     B,TMP    ;ERROR
07FD D1           1249         POP     D        ;DEADBAND
07FE 213300    D  1250         LXI     H,TMP    ;CONTROL REQUIRED
0801 CD0000    E  1251         CALL    SUB32
                  1252
0804 3A3600    D  1253         LDA     TMP+3    ;ERROR < DEADBAND?
0807 07           1254         RLC
0808 C1           1255         POP     B        ;GET ACTION
0809 D8           1256         RC               ;ERROR < DEADBAND, RETURN
080A 78           1257         MOV     A,B
080B B7           1258         ORA     A
080C CA1108    C  1259         JZ      $+5      ;ACTION +,RETURN WITH 00H
080F 3EFF         1260         MVI     A,0FFH   ;ACTION -,RETURN WITH 0FFH
0811 4F           1261         MOV     C,A      ;PUT ACTION IN C
                  1262
0812 3A6800    D  1263         LDA     NEGF     ;WAS ERROR -VE?
0815 B7           1264         ORA     A
0816 CA1C08    C  1265         JZ      $+6      ;NO, ->
0819 79           1266         MOV     A,C      ;YES, COMPLEMENT
081A 2F           1267         CMA
081B 4F           1268         MOV     C,A
                  1269
081C AF           1270         XRA     A        ;CLEAR ACTION FLAG
081D C9           1271         RET
                  1272
                  1273 ;-----------------------------------------------------
```

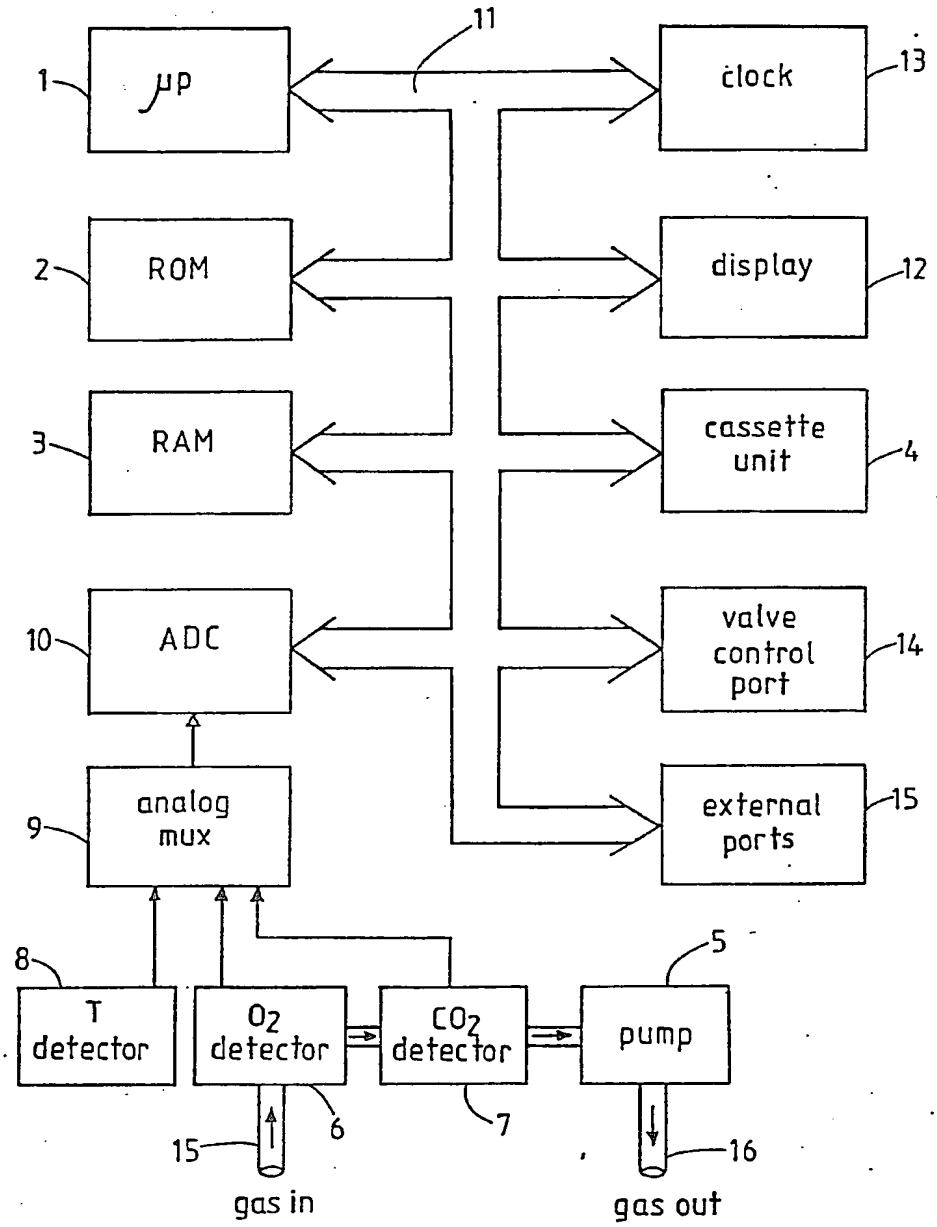
11
1
µp
clock
13
2
ROM
display
12
3
RAM
cassette unit
4
10
ADC
valve control port
14
9
analog mux
external ports
15
8
5
T detector
O2 detector
CO2 detector
pump
15
6
7
16
gas in
gas out

FIG.1

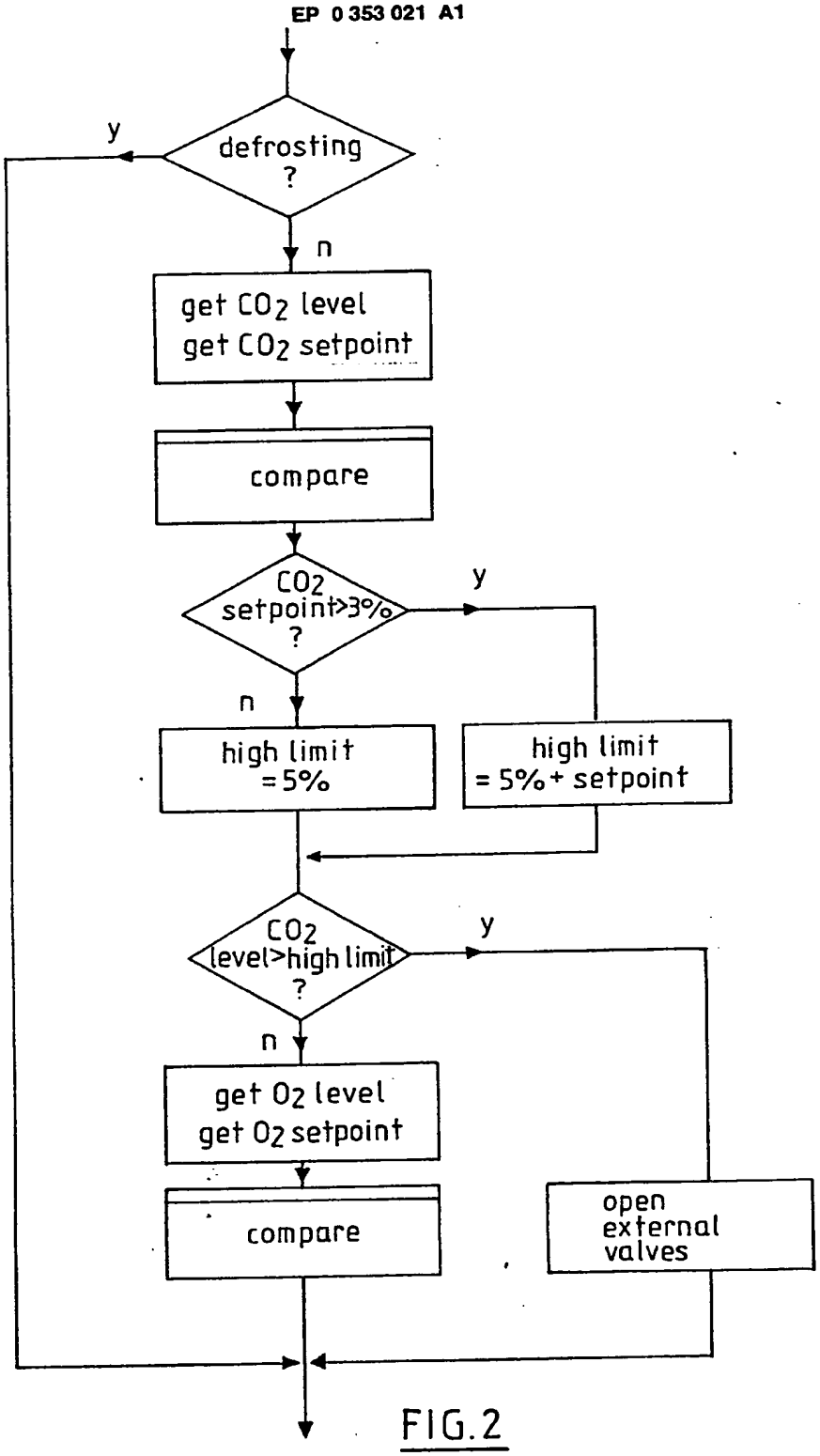
defrosting ?
y
n
get CO_2 level
get CO_2 setpoint
compare
CO_2 setpoint>3% ?
y
n
high limit = 5%
high limit = 5% + setpoint
CO_2 level>high limit ?
y
n
get O_2 level
get O_2 setpoint
compare
open external valves

FIG.2

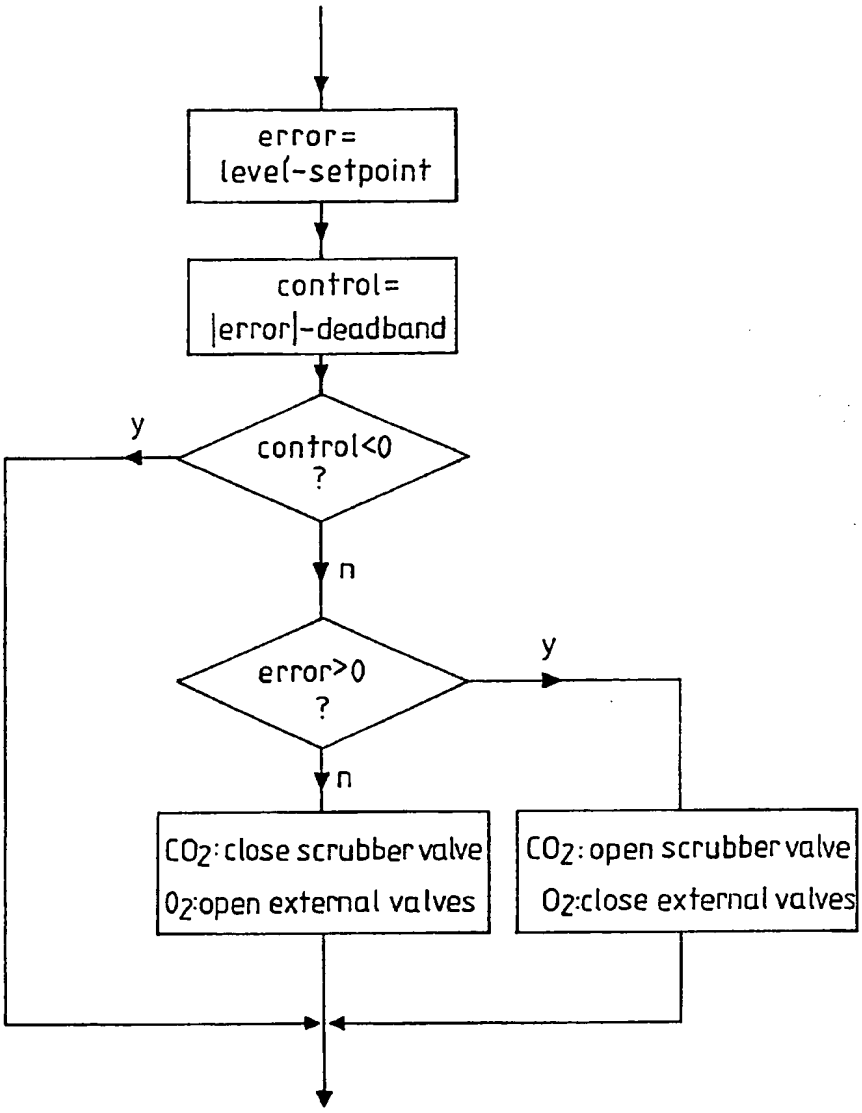
error=
level-setpoint
control=
|error|-deadband
control<0
?
y
n
error>0
?
y
n
CO_2: close scrubber valve
O_2:open external valves
CO_2: open scrubber valve
O_2:close external valves

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 7537

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	WO-A-8 705 782 (VETOSTAR LTD.) * abstract; claims 1,12 *	1	A 23 L 3/34
A	DE-A-3 140 337 (TYCZKA GMBH & CO.) * abstract; claims 1-6 *	1	
A	FR-A-2 520 592 (LUISSIER S.A.) * claims 1-7 *	1	
A	US-A-3 102 779 (A. L. BRODY et al.) * claims 1-8 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 4, no. 151 (C-28)(633), 23 October 1980; & JP - A - 55 99182 (SEIGOU TETSUKOU K.K.) 28.07.1980	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

A 23 L 3/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	26-10-1989	SCHULTZE D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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